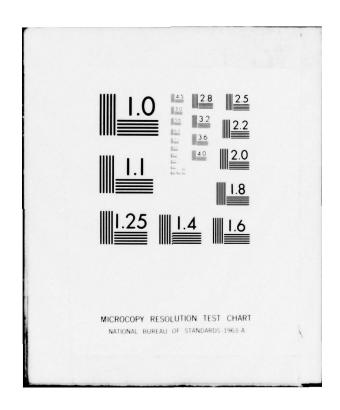
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OHIO RIVER BASIN

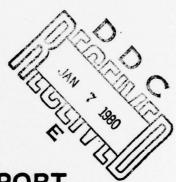
CONNOQUENESSING CREEK, BUTLER COUNTY

PENNSYLVANIA



BOYDSTOWN DAM

NDI No. PA 00270 PennDER No. 10-1



PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers
4301 Duto Ridge Boad
Beaver, Pennsylvania 15009

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AUGUST 1979

Distribution Unlimited Approved for Public Release Contract No. DACW31-79-C-0011

OHIO RIVER BASIN

National Dam Inspection Program. BOYDSTOWN DAM
BUTLER COUNTY, COMMONWEALTH OF PENNSYLVANIA
(NDING. PA 00270
PennDER 10.10-1) -Wumber Onio River Basin, Connoquenessing Creek, Butler County Pennsylvania.

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

31-79-0-0011

Prepared for: DEPARTMENT OF THE ARMY Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

Prepared by:

MICHAEL BAKER, JR., INC. Consulting Engineers 4301 Dutch Ridge Road Beaver, Pennsylvania 15009

Chuan Yuan/Chen

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PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT NATIONAL DAM INSPECTION PROGRAM

Boydstown Dam, Butler County, Pennsylvania NDI No. PA 00270, PennDER No. 10-1 Connoquenessing Creek Inspected 27 June 1979

ASSESSMENT OF GENERAL CONDITIONS

Boydstown Dam is classified as a "Small" size - "High" hazard dam. The dam and reservoir, owned and operated by the Western Pennsylvania Water Company, are used for water supply.

Based upon observations made during the visual inspection, data available from the Pennsylvania Department of Environmental Resources' (PennDER) files, and information obtained from interviewing representatives from the Western Pennsylvania Water Company, the dam is considered to be in very poor overall condition.

Detailed hydraulic/hydrologic evaluations performed by Burgess and Niple, Limited, and supplemented by Michael Baker, Jr., Inc., in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will not pass the Probable Maximum Flood (PMF) without overtopping the dam. The analysis indicated that the spillway will pass only 30 percent of the required PMF before overtopping will occur. As a result of this analysis and others noted in Section 5, the spillway is considered "seriously inadequate." The owner should immediately initiate an engineering study to develop recommendations for remedial measures to reduce the overtopping potential of the dam.

In summary, Boydstown Dam is classified as an "Unsafe" - "Non-emergency" condition dam.

The overall condition of the dam was assessed to be very poor because the upper half of the spillway is in such a deteriorated condition that significant damage to the structure may occur if large flows were to pass through the spillway. In addition, several features of the dam do not meet current design standards; the 7 foot crest width, the lack of an internal drainage system, the absence of positive cut-offs along the outlet and water supply pipes, and the

lack of information concerning the details and condition of the outlet works.

It is recommended that the owner give consideration to reconstruction or breaching the dam as an alternate to performing necessary repairs to the structure. Reconstruction of the dam to meet current design standards would be one method of providing safety for the structure without an extreme amount of expense, considering the relatively narrow valley width. If, however, the economics do not warrant proper repairs or reconstruction, then the reservoir should be drawndown and the dam breached. If the owner feels the dam and reservoir constitutes an important part of their overall water supply system, then the following items should be performed without delay. Items 1, 2, and 3 below should be designed by a qualified professional engineer experienced in the design of earth dams.

- Recommendations for reducing the overtopping potential of the dam should be developed and implemented. (Raising the top of dam without reconstructing the upper half of the spillway would not be acceptable because the spillway in its present condition would not withstand any high velocity discharges.)
- The outlet works should be evaluated and the type, size, and location recorded on engineering drawings for future reference. If any of the outlet pipes are not provided with upstream closure, then procedures should be developed for rapid closure at the upstream end in the event of a pipe rupture.
- The upper half of the spillway should be reconstructed to provide continued stability of the spillway structure against high discharge flows. (As mentioned previously, this can be performed in conjunction with providing the necessary spillway capacity to reduce the overtopping potential of the dam.)
- 4) The dense vegetation on the dam should be cleared and replaced with well maintained grass.
- 5) Riprap or other types of erosion control should be placed on the upstream slope to protect against erosion.
- 6) Proper inspection and maintenance procedures should be developed and implemented. Periodic inspection of the seepage at the right abutment

toe should be included as a part of the inspections. The quantity and turbidity of the seepage should be recorded to identify any changing conditions.

7) Access to the dam should be improved to enable personnel to provide surveillance during flood discharges from Boydstown Dam and high reservoir stages of Lake Oneida.

In addition, the emergency operation and warning system for Lake Oneida should be expanded to include round-the-clock surveillance of Boydstown Dam during periods of unusually heavy rain or in the event of an emergency at the dam.

Submitted by:

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ROFESSIONAL

CHUAN YUAN CHEN

MICHAEL BAKER, JR., INC.

C. Y. Chen, Ph.D., P.E.

Engineering Manager-Geotechnical

Date: 24 August 1979

Approved by:

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK

Colonel, Corps of Engineers

District Engineer

Date: 12 Sep 79

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PLATES

Plate 1 - Location Plan Plate 2 - Watershed Map

Note: No plates which show the current configuration of the dam are available. Please refer to the field sketch for schematic drawings of the dam.

APPENDICES

Appendix A - Check List - Visual Inspection and Field Sketch

Appendix B - Check List - Engineering Data

Appendix C - Photographs

Appendix D - Hydrologic and Hydraulic Computations

Appendix E - Regional Geology

BOYDSTOWN DAM



Overall View of Dam from Left Abutment



Overall View of Downstream Portion of Dam from Left Abutment

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BOYDSTOWN DAM
NDI No. PA 00270, PennDER No. 10-1

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.
- b. <u>Purpose of Inspection</u> The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Boydstown Dam is a diaphragm earthfill embankment approximately 28 feet high (maximum) and 330 feet long. The dam when originally constructed did not contain a corewall; however, a 100 foot section at the right abutment was reconstructed after being overtopped and a masonry stone corewall was installed. Again, after an overtopping failure in the center of the embankment, a concrete corewall was installed from the left end of the masonry stone corewall to the left abutment of the dam. The embankment, in the plan view, is shown to have a slight convex curve downstream. The upstream and downstream slopes are 2.5H:lV (Horizontal to Vertical) and 2H:lV, respectively.

The spillway, at the present time, is located at the left abutment of the dam. The spillway is uncontrolled and the broad-crested weir is 60 feet long (perpendicular to flow). The flow, after passing over the weir, travels through a flat concrete paved channel before cascading down a series of concrete steps into the stilling basin. The right side of the discharge channel has a training wall 8 feet high and is made of masonry stone for the upper half and concrete for the lower half. The left side of the channel is sloped back and rubble-lined for the first half and then is a concrete training wall along the series of steps.

The riser tower is circular and consists of masonry stone. Three gated intake levels are located on the upstream half of the tower. The flow then enters a gated pipe (believed to be a 16 inch water supply line) and subsequently discharges below the dam from a gated "wye" on the water supply line. According to the owner's personnel, this water supply line is no longer used for water supply. In addition, the owner's personnel indicated that a 20 inch blow-off pipe and a 24 inch wooden water supply pipe run from the intake tower to the downstream pool and treatment plant respectively. should be noted here that some confusion exists as to the outlet works in the dam since no drawings of the outlet works are available from either the Pennsylvania Department of Environmental Resources' [PennDER] file or from the owner. The 1915 Water Supply Commission Report details the outlet works at that time according to the information available. The water company's information is based upon a diver's description approximately five years ago when repairs were performed in the intake tower. This information has been gathered from the recollection of the people involved at that time.)

- b. Location Boydstown Dam is located in Oakland Township, Butler County, Pennsylvania, approximately 900 feet east of Boydstown, Pennsylvania. The coordinates of the dam are N. 40° 56.3' and W. 79° 50.6'.
- c. <u>Size Classification</u> The maximum height of Boydstown Dam is 28 feet. The reservoir volume to the top of the dam at El. 1078.4 feet is 514 acre-feet. Therefore, the dam is in the "Small" size category.
- d. Hazard Classification Lake Oneida Reservoir and Dam (NDI No. PA 00272) are located immediately downstream from Boydstown Dam. In the event of a failure of Boydstown Dam, it is likely that Lake Oneida Dam will be overtopped and will subsequently fail. Lake Oneida Dam and Reservoir have been assigned a "High" hazard classification by GAI Consultants, Inc., Phase I Inspection Report, dated September 1978. Therefore, Boydstown Dam is also considered in the "High" hazard category.
- e. Ownership The dam and reservoir are owned and operated by the Western Pennsylvania Water Company, Butler District, 105 Lincoln Avenue, Butler, Pennsylvania 16001.

- f. Purpose of Dam The dam and reservoir are used for water supply purposes and limited recreational use.
- g. Design and Construction History The construction of the dam was started sometime prior to 1896 to provide a water supply reservoir along Connoquenessing Creek above an area of salt water pollution (as a result of oil wells). Mr. George Schaffner was the contractor for the original construction of the dam. The dam was started by private concerns and then sold to the Butler Water Company (predecessor to Western Pennsylvania Water Company, present owner of the dam) after a lack of funds prevented the completion of the dam. The Butler Water Company then finished the dam in 1896.

On 27 July 1897, after a heavy rain, a portion of the embankment near the right end of the dam washed out after being overtopped. Subsequently, the breach was repaired under the direction of Mr. James Morrow.

On 28 August 1903, after a rainfall estimated at 8 inches in 4 hours and 15 minutes (the amount of rainfall was heavily disputed in the information reviewed) the embankment was again overtopped and a different segment of the embankment washed away. The embankment was again repaired under the direction of Mr. James Morrow.

During the afternoon and evening of 1 October 1911, a precipitation of 2.9 inches fell in approximately 4 hours, resulting in a depth of flow through the spillway of 67 inches. During this flood, a timber apron located at the downstream end of the spillway was washed away from the timber sheet piling to which it was fastened. No damage to the embankment occurred and the apron was replaced with a concrete stilling basin.

As a result of the noted failures of the dam and because of deterioration, the spillway for the dam has undergone numerous changes and reconstructions. It was noted that the original spillway (30 foot long, perpendicular to the flow, with the crest 6.5 feet below the top of embankment) was located in the center of the embankment. This timberlined and timber cribbed supported spillway was removed and replaced after the 1897 failure of the dam. A new spillway, 50 feet long and 6.8 feet deep, was constructed of masonry stone and mortar

at the left end of the dam. Subsequent to the 1903 failure, the embankment was raised to a level 8 feet, 2 inches above the spillway crest and the spillway was revised from a long channel to a broadcrested weir with series of concrete steps below it. As noted above, the timber spillway apron was replaced with a concrete stilling basin after its failure in 1911.

As a result of an inspection performed by a representative of the Water Supply Commission in 1915, the spillway size was increased in 1916 to a 60 foot length (perpendicular to flow). In addition, the left training wall was removed and the left side cut back to a 2H:1V masonry rubble-lined slope. During the intervening years, between 1916 and the present, the spillway has been inspected and noted to need immediate repairs. The known years when repairs were performed to the spillway include 1934, 1948, and 1953. It should be noted that in 1949, an additional study was performed on the spillway at Boydstown and it was decided that additional spillway capacity was necessary. At that time the spillway capacity was evaluated to be 3860 c.f.s. and that the spillway needed a capacity of 14,700 c.f.s. The computed 3860 c.f.s. is only 26 percent of that which was calculated to be required. No known changes were performed on the spillway to meet the desired discharge capabilities.

h. Normal Operational Procedures - The spillway is uncontrolled and the outlet pipe is at least partially open (if not fully open) and the controlling valve is never adjusted. The dam is visited daily for checking the reservoir level and completing a maintenance check list.

1.3 PERTINENT DATA

a. Drainage Area (square miles) - 13.6

b. Discharge at Dam Site (c.f.s.) -

Maximum Flood - Unknown
Spillway Capacity
(at Pool El. 1078.4 ft.) - 3100

c.	Elevation (feet above Mean Sea Level [M.S.L.	<u>n</u> -
	Top of Dam - Maximum Pool (Hydrologic and Hydraulic Analysis¹) - Spillway Crest - Streambed at Centerline of Dam² - Maximum Tailwater of Record³ -	1078.4 1082.3 1071.2 1050+ 1063.6
d.	Reservoir (feet) -	
	Length of Maximum Pool - Length of Normal Pool -	6650 35 4 0
e.	Storage (acre-feet) -	
	Top of Dam (El. 1078.4 ft.) - Normal Pool (El. 1071.2 ft.) -	514 236
f.	Reservoir Surface (acres) -	
	Top of Dam (El. 1078.4 ft.) - Normal Pool (El. 1071.2 ft.) -	52 24
g.	Dam -	
	Type - Diaphragm Length (feet) - Height (feet) - Top Width (feet) - Side Slopes - Upstream - - Downstream - Zoning - Impervious Core - Masonry stone core wall rice 2 foot thick concrete core maining length of dam. Cut-off - Grout Curtain - Drains -	330 28 7 2.5H:1V 2H:1V None pht 100 feet,
h.	Diversion and Regulating Tunnel -	None

¹Maximum reservoir level during the Probable Maximum Flood as determined by Burgess and Niple, Limited.

²Estimated from top of dam elevation and designated height of dam.

³From Phase I Inspection Report - Lake Oneida Dam.

i. Spillway -

Type
Length of Crest (feet)
Crest Elevation (feet M.S.L.)
Gates
Upstream Channel - Riprap-lined reservoir shore.

Downstream Channel - Flat concrete paved channel for first half exiting into a series of concrete steps. A stilling basin is located at the end of the steps and Lake Oneida normally forms the tailwater elevation in the stilling basin.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Boydstown Dam was completed in 1896; therefore, it is estimated that it was designed based on local experience for similar dams. The only design information available for this dam is PennDER's File No. 10-1. Information in this file includes:

- 1) "Report Upon the Boydstown Dam of The Butler Water Company," prepared by the Water Supply Commission of Pennsylvania (predecessor to PennDER) and dated 20 January 1915.
- 2) Design drawings showing the plan view of the dam and changes to the spillway.
- Various correspondence, memorandums, and inspection reports.

2.2 CONSTRUCTION

The construction of the dam was started sometime prior to 1896. The construction of the dam was completed in 1896 by the Butler Water Company after others were financially unable to complete it. The original contractor is reported to have been Mr. George Schaffner.

The dam, as originally constructed, consisted of an "earth and clay" embankment with a timber plank core wall. The embankment was reportedly "to have been constructed upon the natural surface of the valley, the selected material being deposited on the upstream side and the inferior material on the downstream side of the core wall, in thin layers and compacted by teaming." The embankment, in the plan view, was constructed with a slight convex curve downstream. The timber core wall consisted of two 1 inch layers of oak planks placed in a trench excavated to the top of rock. Lagging (2 by 4 inches at the base and 2 by 6 inches at the top of the planks) secured the planks.

The original spillway was located in the center of the embankment at the stream channel, and was formed of 2 inch planks, spiked to the top of rock and clay filled timber cribs. It was reported to have been 30 feet in length, with its crest 6.5 feet below the top of the embankment. The training walls of this spillway were formed by timber bulkheads, which supported and protected the sides of the embankment. The

vertical upstream face of the timber crib supported the timber cut-off wall and the downstream end was protected from backwash and undermining by sheeting which extended from the floor of the channel to the bedrock.

The original outlet works consisted of a stone masonry circular intake tower with a 12 foot inside diameter and three gated controlled openings. (This intake tower and gates are still present and functional.) A 12 inch terra cotta pipe passing through the embankment and controlled by a gate within the intake tower was used for water supply. Parallel to the terra cotta pipe was a 30 inch square wooden flume constructed of 2 by 4 inch timbers spiked together. This flume was also controlled by a gate and was intended to act as the drawdown facility (and supplement to the spillway). During the first winter after construction, the terra cotta pipe had to be replaced by a 16 inch cast-iron main and valve because the weight of the embankment crushed the terra cotta pipe.

On 27 July 1897, after a heavy rain, (no record of rainfall available) a portion of the embankment approximately 100 feet in length between the right (west) end of the dam and the spillway (the wooden spillway which was then in the center of the dam) was overtopped and washed out. The breach was repaired as soon as possible after the failure under the direction of Mr. James Morrow. As a part of the repair, a 24 inch rubble masonry core wall extending from rock to the top of the dam was constructed in place of the timber core wall in the breached area.

In 1897, the timber spillway at the center of the dam was removed and replaced with a 50 foot crest length spillway at the left end of the dam. The structure of masonry stone and mortar was placed on the natural ground surface. The floor of the channel, concrete paved, had a nearly level slope from the crest of the spillway to the discharge chute. At the end of the chute was a heavy timber apron, secured to timber sheet piling at the upstream end.

The outlet works were also revised in 1897. A 16 inch cast-iron water supply pipe ran from inside the intake tower to a pumping station (location unknown) downstream from the dam. A 24 inch cast-iron blow-off pipe was also installed with the upstream end open to the reservoir and the downstream end regulated by a gate valve. The water supply pipe was also provided with a gate valve on the downstream side of the embankment.

On 28 August 1903, precipitation estimated at 8 inches in 4 hours and 15 minutes (a later memorandum in the PennDER File reports that a value of 3.19 inches reported by the Weather Bureau is more representative of the actual average precipitation than the unofficial value of 8 inches obtained by farmers measuring the rainfall in buckets) occurred and caused the embankment to be overtopped to a depth of 12 inches at a low spot on the embankment. This low section subsequently washed out. It was reported that the width of the breach was 130 feet and was located between the new spillway and the portion of the embankment that was breached in 1897 (this would be in the center and a little left of center of the dam). At the time of the flood, the spillway crest had 24 inches of flashboards on it.

Repairs were started as soon as possible after the flood under the direction of Mr. James Morrow. A 24 inch thick concrete core wall was then constructed from the left end of the dam and connected with the masonry stone core wall constructed in 1897. The core wall was reported to be constructed upon the rock foundation and extending to the top of the embankment. The breach area of the embankment was then repaired with "clay spread in thin layers, wetted and tamped." The entire length of the embankment was then raised approximately 1.5 feet above the previous top of dam elevation. (This made the top of the embankment 8 feet, 2 inches above the spillway crest elevation.) Changes were also made to the spillway at this time. These changes consisted of plugging the sockets for flashboard braces and revising the spillway from a long level section channel at the crest to a broad-crested weir with a series of concrete steps carrying the discharge away. (This is estimated to have increased the hydraulic capacity of the spillway.)

During the afternoon and evening of 1 October 1911, a precipitation of 2.9 inches fell in 4 hours, resulting in 67 inches of water passing through the spillway (with the blow-off pipes open). During this flood, the timber apron at the downstream end of the spillway channel washed away. This apron was then replaced with a concrete stilling basin with saw-tooth energy dissipators at the upstream end of the basin.

On 12 January 1915, a representative of the Water Supply Commission made an inspection of the dam and subsequently wrote a report dated 20 January 1915 from which most of the above information was obtained. As a result of this inspection, it was recommended that the spillway be revised to be capable of discharging

6750 c.f.s. This figure was later reduced to 4100 c.f.s. This inspection also indicated that the plunge pool for the outlet pipe was riprapped and that a "wye" had been placed on the 16 inch water supply pipe. The branch pipe of the water supply pipe outletted into the plunge pool and was gated to be used for drawdown if necessary.

In 1916, the spillway was enlarged from a 50 foot wide rectangular channel to a 60 foot wide channel at the base with the left side cut back on 2H:1V slope. The slope was protected with hand placed masonry rubble riprap.

As a result of various inspections performed by Water Supply Commission representatives (and other predecessors of PennDER), the spillway was repaired in 1934, 1948, and a major reconstruction of the bottom half of the spillway in 1953. In 1953, the stilling basin was modified as a result of the reconstruction, with the energy dissipator blocks being installed at the downstream end of the stilling basin.

In 1916, seepage was reported exiting from the toe of the slope of the dam at the right abutment and the right hillside near the dam. Seepage weir measurements recorded in 1916 and 1917 indicate a relationship between the level of the reservoir and the volume of seepage exiting this area. This seepage was observed during various inspections performed from 1916 to 1948. The last inspection noting the seepage (1948) described it as "heavy" and that it would probably fill a 6 inch or 8 inch tile pipe. The only other inspection report available since 1948 was an inspection performed on 29 April 1964. This inspection report did not indicate that any seepage was present; however, it also did not indicate the reservoir level at the time of inspection.

According to a representative of the Western Pennsylvania Water Company, some repair work was performed in the intake tower approximately five to ten years ago. He did not know the details but indicated that the stems and valves were reconditioned or replaced.

2.3 OPERATION

The blow-off pipe is reportedly kept open at all times and is not regulated. The reservoir level is recorded and records are available back to 1954. In the fall of 1978, the water company started procedures for daily inspection of the dam and a check list for items observed for these inspections was instituted.

2.4 EVALUATION

- a. Availability The only design information available consisted of PennDER's File No. 10-1. Some of the history of the dam has been summarized above but the 1915 Water Supply Commission report contains most of the available information on the construction of the dam. No drawings showing a cross section of the embankment are available. No drawings showing information about the intake tower, blow-off pipes, outlet structure, location of water supply lines, foundation conditions, embankment zoning, and incorporation of an internal drainage system are available.
- b. Adequacy The information available is adequate for a Phase I Inspection of this dam.
- c. Validity Much of the information is based upon the Water Supply Commission report. The information contained in that report was obtained by reviewing any information available at that time and by intervising the people associated with the operation and repairs performed to the dam. Based upon the field observations and experience with the Water Supply Commission reports on other dams, it is concluded that the information is the most complete and valid information available excepting the noted modifications performed on the dam after 1915.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General The inspection was performed on 27 June 1979 and no unusual weather conditions were present. The pool was 5.6 feet below the level of the spillway crest at the time of inspection. The dam and appurtenant structures were in very poor overall condition. Noteworthy deficiencies are described briefly below. The complete visual inspection check list and field sketch are presented in Appendix A.
- b. Dam Clear seepage was observed exiting from the toe of the right hillside approximately 50 feet downstream from the junction of the embankment and right abutment. The estimated rate of flow was 2 g.p.m. from a fractured sandstone formation.

The embankment is covered with dense vegetation and small trees, making the visual inspection of the embankment and toe difficult. The crest of the embankment is only 7 feet wide and consists of sandy and clayey silt (ML-CL). The riprap on the upstream face has deteriorated and weathered to the point that the right side does not appear to have any riprap. Some minor wave erosion was observed on the right-center of the dam. No observation of horizontal alignment could be made because of the original slightly curved plan of the dam and no detailed "as built" drawings. The top of dam survey indicated a 0.5 foot difference between the left and right ends of the dam.

c. Appurtenant Structures - The spillway, especially the upstream half of the discharge channel and the right training wall, is very deteriorated. Cracking and undermining of the concrete slab has occurred (see Photo 9 for an example). Also, the right training wall at the entrance to the spillway has several of the sandstone blocks missing and is tilted into the spillway several inches (see Photo 10). The downstream half of the discharge channel and the stilling basin appeared to be in good condition; however, some cracking has occurred on the vertical face of several of the steps.

The intake tower was in fair condition with only a couple of boards on the walkway to the tower starting to rot away. The mortar between the

stones appeared to be in fair condition; however, the submerged portion of the tower could not be checked. The valve stem for the lowest level intake was disconnected at the time of the inspection. The remainder of the valves (gates) appeared to be functional but in need of preventive maintenance.

The outlet structure and outlet conduits were totally submerged and could not be examined. The outlet conduit was at least partially open and flow was entering Lake Oneida at the time of the inspection.

d. Reservoir Area - The area surrounding the reservoir is moderately sloping and highly forested. The reservoir at the time of inspection was 5.6 feet below the spillway crest elevation. No problems were observed in the reservoir area.

Upstream from the reservoir are several small farm ponds, one of which was examined. The others were on posted private property and were not examined. It is felt that these ponds will not significantly affect Boydstown Dam.

e. Downstream Channel - Lake Oneida Dam and Reservoir (NDI No. PA 00272) are located immediately downstream from Boydstown Dam. It has been reported that approximately 60 to 80 people might be affected by failure of Lake Oneida Dam. Since failure of Boydstown Dam is likely to cause a failure of Lake Oneida Dam under present conditions, and no other residences were located in low-lying areas along Lake Oneida shoreline, it is concluded this same approximate number of people would be affected by failure of Boydstown Dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written procedures in the event of impending failure of the dam. The condition of the dam is reportedly checked every day by personnel from the water company. At the time of the inspection, the drawdown facilities were at least partially open and according to water company personnel, remain in that position all the time.

At the present time, formal emergency procedures are being developed for Lake Oneida Dam. It is recommended that these emergency procedures be extended to include emergency operation and surveillance of Boydstown Dam.

4.2 MAINTENANCE OF DAM

The Western Pennsylvania Water Company is responsible for maintenance of the dam. At the present time, the maintenance of Boydstown Dam is very inadequate. It is recommended that formal maintenance procedures be developed and implemented, including upgrading the access to the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

The Western Pennsylvania Water Company is responsible for maintenance of the operating facilities. Although maintenance of these facilities has been performed at various times in the past, no formal schedule or record of the maintenance is presently in use. It is recommended that operation and preventive maintenance schedules be developed and implemented.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The formal emergency warning system currently being developed for Lake Oneida Dam should be adapted to include Boydstown Dam.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

According to information contained in the PennDER file for this dam, the outlet pipe for this dam is open to the reservoir and does not have a closure on the upstream side of the embankment. Since a number of uncertainties exist as to the location and condition of this conduit, it is recommended that an investigation be performed at a time when Boydstown Reservoir is at low pool. Also,

the lower portion of the riser, intakes, and gates should be examined at the same time. When the pool of Lake Oneida is low, it is recommended that a detailed inspection of the outlet structure and outlet works be performed.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. <u>Design Data</u> No hydrologic or hydraulic design calculations are available for Boydstown Dam.
- Experience Data On 27 July 1897, following heavy rains, a 100 foot wide section of the embankment washed out as the result of overtopping of the dam. On 28 August 1903, the dam was again overtopped by approximately 12 inches resulting in a 130 foot long breach in the embankment. The rainfall over the watershed prior to the failure was estimated at 4.2 inches during a 4.25 hour period. The maximum discharge from the dam was estimated at 4300 to 4800 c.f.s. On 1 August 1911, the timber apron at the lower end of the spillway was destroyed as the result of excessive discharges through the spillway. The storm, 2.9 inches of rainfall in 4 hours, resulted in 67 inches of flow passing through the spillway and a maximum discharge from the reservoir of approximately 2450 c.f.s.

No failures of the dam or its appurtenances have occurred since 1911. However, the spillway has been activated numerous times. On 29 August 1923, the reservoir rose to a level of 56 inches above the spillway crest. Reservoir stage records have been maintained by the owner since 1954. The largest flood since that time occurred in 1954 when the reservoir rose 52 inches above the spillway crest following 3.3 inches of rain in the preceding 24 hours.

- c. Visual Observations The right training wall of the spillway, near the control section, is cracked and horizontally separated at the top of the wall by several inches. Generally, the upper end of the spillway is deteriorated and in poor overall condition. Structural failure of the spillway could possibly occur in the event of a storm equal to or greater than that of 1954.
- d. Overtopping Potential Boydstown Dam is a "Small" size "High" hazard dam requiring evaluation for a spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Oneida Dam, located immediately downstream from Boydstown Dam, is an "Intermediate" size "High" hazard dam which has been evaluated

for a SDF equal to the PMF. In view of this, the PMF was also chosen as the SDF for Boydstown Dam, since an overtopping failure of this dam could significantly affect the hydraulic capabilities of Oneida Dam.

Hydrologic and hydraulic analysis of the Boydstown Dam was performed by Burgess and Niple, Limited as part of their detailed study of the Oneida Dam just downstream. As their analysis appears to be reasonable, the results of their study were utilized in this study.

A brief description of the analysis performed by Burgess and Niple is as follows. Additional information is contained in Appendix D of this report. The runoff hydrograph for the watershed was computed by the unit hydrograph method. The unit hydrograph for Boydstown Dam (and Oneida Dam) was constructed by transforming unit hydrographs from four other watersheds in the same hydrologic region having similar basin characteristics. Stage versus storage data was determined from recent aerial mapping. The U.S. Army Corps of Engineers' Water Surface Profiles computer program, HEC-2, was used to develop the spillway discharge rating.

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers, Flood Hydrograph Package, HEC-1. The PMF hydrograph developed as part of this analysis had a peak discharge of 12,180 c.f.s., using a 72 hour probable maximum precipitation (PMP) of 29.4 inches. The results of this routing indicate that the dam would be overtopped by 3.9 feet and 1.9 feet by the PMF and 1/2 PMF respectively. The dam is capable of passing a flood of only 30 percent of the PMF.

- e. Spillway Adequacy The dam, as outlined in the above analysis, would be overtopped by the PMF. The criteria for spillway adequacy determination requires an estimate of the downstream damage increase during overtopping by 1/2 PMF conditions. Therefore, the following conditions, as well as historical evidence, were used as the limiting criteria which are likely to cause failure of this dam.
 - Depth of overtopping of 1.0 foot or greater.

2) Duration of overtopping in excess of-2 hours.

The overtopping analysis of this dam yielded the following values.

- 1) 1.9 feet
- 2) 14 hours

Therefore, dam failure during the above 1/2 PMF conditions is likely to occur.

To assess the impact of the dam failure on the downstream area, the 1/2 PMF was routed downstream to the Oneida Dam. The results of this flood routing indicated that the extent of overtopping of Oneida Dam would be increased significantly in the event of a failure of the Boydstown Dam by overtopping. In addition to an increase in the maximum water surface elevation of the Oneida Reservoir, the peak discharge would arrive at the Oneida Dam much sooner than if Boydstown Dam had not failed. According to a Phase I Inspection Report prepared by GAI Consultants, Inc., September 1978, an overtopping failure of Oneida Dam would significantly increase the potential hazard to residents downstream from that hazard which would exist just prior to failure. The report also stated that the dam was capable of passing only 30 percent of the PMF and that overtopping of the dam is expected to cause failure of the embank-Therefore, failure of the Boydstown Dam by overtopping would cause a significant increase in damages in the areas downstream from the dam compared to damages resulting from nonfailure of the dam.

Based on the above results, the spillway is classified as "seriously inadequate" according to the recommended criteria.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

Visual Observations

- (1) Embankment As discussed in Section 3, the field observations did not reveal any signs of distress which would affect the structural stability of the embankment, however, it must be pointed out that the dense vegetation on the embankment and the proximity of Lake Oneida to the toe of the embankment severely hampered the visual inspection. It is recommended that the owner clear the vegetation from the The owner should then have a registered professional engineer experienced in inspection and evaluation of earth dams perform an inspection of the areas where the vegetation hindered the inspection. This additional inspection can be performed as a part of PennDER's requirement for annual inspections of this dam.
- (2) Appurtenant Structures The right spillway training wall at the entrance to the spillway raises concern as to the continued stability of this wall. It is considered that remedial work should be performed to prevent a potentially catastrophic occurrence during flood flows. This work could possibly be performed as a part of the recommendation to provide additional spillway capacity. A number of uncertainties exist in relation to the condition and safety of the outlet works associated with the dam. Therefore, it is recommended that these be inspected and evaluated by a registered professional engineer experienced in the design of hydraulic structures for earth dams.
- b. Design and Construction Data Given the age of the structure and the state-of-the-art at the time of the construction of the dam, it is doubtful that any structural stability analyses have been performed for this dam. In view of the history of satisfactory performance of the slopes and the fact that no indications of instability were observed during the field inspection, no further stability assessments are necessary for this Phase I Inspection Report. For this particular dam, it

should be pointed out that the vegetation on the dam hindered the inspectors and the reservoir was not at normal pool during the inspection. Should future inspections observe signs of distress which would affect the structural stability of the embankment, additional evaluations and possibly corrective measures may be necessary.

- c. Operating Records The records available consist of the reservoir levels in Boydstown Reservoir and Lake Oneida. Nothing in these records or the operating procedures indicates concern relative to the structural stability of the dam.
- d. Post-Construction Changes Numerous changes have been performed (see Section 2) to the dam. Most of these changes have hopefully improved the structural stability and safety of the structure. However, numerous uncertainties concerning these changes exist, (i.e., were the core walls keyed into the bedrock, were they keyed into the abutments, type of backfill used, how much of the original timber crib spillway is still remaining in the dam) thus making an assessment of their effects on the structural stability difficult.
- e. Seismic Stability The dam is located in Seismic Zone I on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspections of Dams." This is a zone of very low seismic activity. Experience indicates that dams in this zone will have adequate stability under seismic loading conditions provided static stability conditions are satisfied and conventional safety margins exist. As indicated in paragraph 6.1.b., further assessment of the static stability is recommended. If the evaluation and subsequent recommendations provide sufficient static stability factors of safety, then the dam should have sufficient seismic stability.

7.1 DAM ASSESSMENT

a. Safety - Boydstown Dam is evaluated as a "High" hazard - "Small" size dam and should have a hydraulic capacity sufficient to pass the PMF. As presented in Section 5, the spillway and reservoir were determined to have a capacity of only 30 percent of the PMF. Based upon this analysis and others noted in Section 5, the spillway is considered "seriously inadequate."

As a result of the spillway analyses and observations, Boydstown Dam is classified as an "Unsafe" - "Non-emergency" dam.

The overall condition of the dam at the time of inspection was very poor. The upper half of the spillway is in a deteriorated condition such that if a large flood discharge were to pass through the spillway, significant damage to the spillway structure would occur. The crest width of the embankment (7 feet) is insufficient according to current standards. In addition, several other features of the dam do not meet current design standards, i.e., lack of internal drainage system, the absence of positive seepage cut-offs along the outlet and water supply pipes. During the visual inspection, seepage was observed along the right abutment toe. This seepage is not considered to adversely affect the structural stability at this time because of its presence being noted as early as 1915 and the fact that transportation of fine material was not occurring at the time of inspection. Historical data from a seepage weir in 1916 and 1917 indicates that the amount of flow is responsive to reservoir fluctuations above a base amount of seepage flow (probably from natural groundwater). Therefore, it is recommended that the seepage be observed in the future for increased flow and turbidity.

b. Adequacy of Information - Generally, the information available is adequate to make an overall assessment of the dam, however, information concerning numerous important features of the dam is superficial and based upon word of mouth. It is recommend that additional information concerning these features be investigated as discussed in paragraph 7.1.d.

and properly placed on engineering drawings for future reference.

- c. <u>Urgency</u> The owner should initiate without delay further investigation, as discussed in paragraph 7.1.d.
- d. Necessity for Additional Data/Evaluation The hydraulic/hydrologic analysis performed for this dam has indicated the need for additional spillway capacity. Since the owner has already had a detailed analysis of the spillway capacity performed in conjunction with Lake Oneida Dam located downstream, additional evaluation of the spillway capacity is not necessary. However, recommendations for reducing the overtopping potential for the dam should be developed and implemented.

The owner should have a qualified professional engineer experienced in the design of hydraulic structures for earth dams perform an evaluation of the outlet works for this dam. Information concerning the details of the outlet works should be placed on engineering drawings for future reference.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

It is recommended that the owner give consideration to reconstructing or breaching the dam as an alternate to performing necessary repairs to the structure. Reconstruction of the dam to meet current design standards would be one method of providing safety for the structure without an extreme amount of expense considering the relatively narrow valley width. If, however, the economics do not warrant proper repairs or reconstruction, then the reservoir should be drawndown and the dam breached. If the owner feels the dam and reservoir constitutes an important part of their overall water supply system, then the following items should be performed without delay. Items 1, 2, and 3 below should be designed by a qualified professional engineer experienced in the design of earth dams.

 Recommendations for reducing the overtopping potential of the dam should be developed and implemented. (Raising the top of dam without reconstructing the upper half of the spillway would not be acceptable because the spillway in its present condition would not withstand any high velocity discharges.)

- The outlet works should be evaluated and current type, size, and location recorded on engineering drawings for future reference. If any of the outlet pipes are not provided with upstream closure, then procedures should be developed for rapid closure at the upstream end in the event of a pipe rupture.
- 3) The upper half of the spillway should be reconstructed to provide continued stability of the spillway structure against high discharge flows. (As mentioned previously, this can be performed in conjunction with providing the necessary spillway capacity to reduce the overtopping potential of the dam.)
- 4) The dense vegetation on the dam should be cleared and replaced with well maintained grass.
- 5) Riprap or other types of erosion control should be placed on the upstream slope to protect against erosion.
- 6) Proper inspection and maintenance procedures should be developed and implemented. Periodic inspection of the seepage at the right abutment toe should be included as a part of the inspections. The quantity and turbidity of the seepage should be recorded to identify any changing conditions.
- 7) Access to the dam should be improved to enable personnel to provide surveillance during flood discharges from Boydstown Dam and high reservoir stages of Lake Oneida.

In addition, the emergency operation and warning system for Lake Oneida should be expanded to include around-the-clock surveillance of Boydstown Dam during periods of unusually heavy rain or in the event of an emergency at the dam.

PLATES

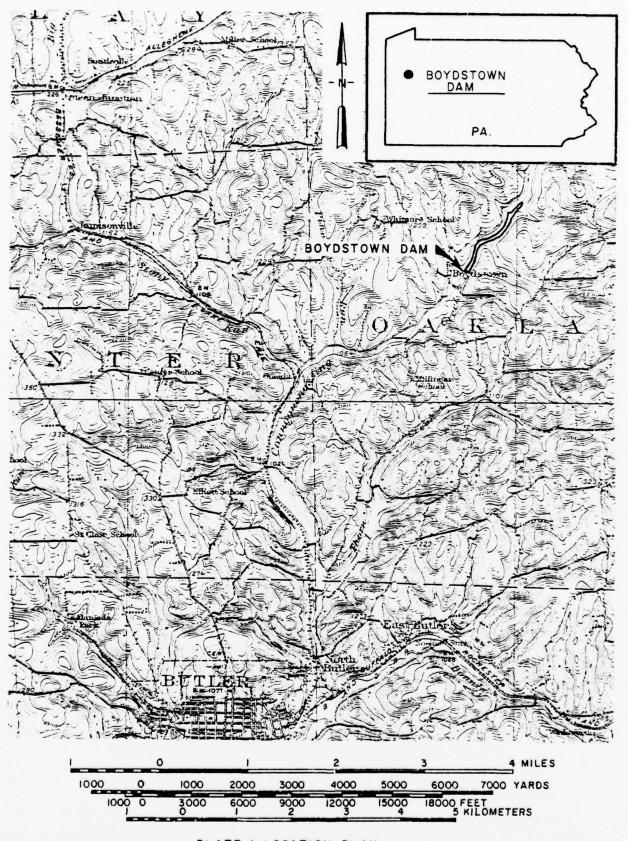


PLATE I LOCATION PLAN
BOYDSTOWN DAM



BOYDSTOWN DAM

APPENDIX A

CHECK LIST - VISUAL INSPECTION AND FIELD SKETCH

Check List Visual Inspection Phase 1

Long. W 79° 50.6' Coordinates Lat. N 40° 56.3' PA State Butler County Name of Dam Boydstown Dam NDI # PA 00270 PennDER # 10-1

Temperature 85°F. Date of Inspection 27 June 1979Weather Sunny, Warm Pool Elevation at Time of Inspection 1065.6 ft. M.S.L. Tailwater at Time of Inspection 1055.1 ft. M.S.L.

Inspection Personnel:

Corps of Engineers, Baltimore District:

Edward Hecker

Michael Baker, Jr., Inc.:

Dr. C. Y. Chen Rodney E. Holderbaum James G. Ulinski

Mr. Al Reeder, Operations Manager Butler District

Western Pennsylvania Water Company:

Owner's Representative

William H. McAdams, Engineer Raymond A. Dami

Site Visit - 19 July 1979

Dr. C. Y. Chen James G. Ulinski

Recorder James G. Ulinski

Name of Dam: BOYDSTOWN DAM	CONCRETE/MASONRY DAMS - Not Applicable	
NDI # PA 00270		
VISUAL EXAMINATION OF	OBSERVATIONS REMARKS OR RECOMMENDATIONS	MMENDATIONS
TEAKACE		

STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS

DRAINS

WATER PASSAGES

FOUNDATION

CONCRETE/MASONRY DAMS - Not Applicable

NDI # PA 00270		
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

STRUCTURAL CRACKING

CONCRETE SURFACES

VERTICAL AND HORIZONTAL ALIGNMENT

MONOLITH JOINTS

CONSTRUCTION JOINTS

EMBANKMENT

Name of Dam: BOYDSTOWN DAM

NDI # PA 00270

VISUAL EXAMINATION OF OBSERVATIONS

SURFACE CRACKS

None observed

UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE

None observed

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES

Some wave erosion have occurred on the upstream slope.

The areas should be repaired and adequate riprap protection provided.

VERTICAL AND HORIZONTAL TALIGNMENT OF THE CREST A

The dam was constructed in a curve making an assessment of the horizontal alignment difficult. The level survey performed during the visual inspection indicated 0.5 ft. difference from the left end of the dam to the right abutment.

RIPRAP FAILURES

The riprap on the upstream face is disintegrated The upstread and missing in some places.

d The upstream slope should be protected with an adequate amount of properly bedded riprap.

EMBANKMENT

DAM	
BOYDSTOWN	
Dam:	PA 00270
of	d #
Vame	ION

VEGETATION At the time of the inspection, the dam was covered with thick vegetation making it grass should be cleared difficult to observe all of the embankment. JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM ANY NOTICEABLE Seepage was observed exiting from the right hillside approximately 50 ft. downstream from the embankment, right abutment junction. The clear flow was exiting at an estimated 2 g.p.m. A wet and marshy area is located downstream from the center of the dam. This area may be the result of tailwater from Lake Oneida. STARF GAGE AND RECORDER None The vegetation should be cleared and required properties. The grass should then be cut frequently to facilitate future inspections. The vegetation should be cleared deared frequently to facilitate future inspections. It is recommended that the dam be examined again in the future under right and marshy area is low officially area is low enough to observe the outlet pipe for Boydstown Dam.	VISUAL EXAMINATION OF	OF OBSERVATIONS	REMARKS OR RECOMMENDATIONS
No problems observed was observed exiting from the right hillside mately 50 ft. downstream from the embankment/ tbutment junction. The clear flow was exiting stimated 2 g.p.m. A wet and marshy area is i downstream from the center of the dam. This iy be the result of tailwater from Lake Oneida. None	VEGETATION	At the time of the inspection, the dam was covered with thick vegetation making it difficult to observe all of the embankment.	The vegetation should be cleared and replaced with grass. The grass should then be cut frequently to facilitate future inspections.
was observed exiting from the right hillside mately 50 ft. downstream from the embankment/lbutment junction. The clear flow was exiting stimated 2 g.p.m. A wet and marshy area is downstream from the center of the dam. This y be the result of tailwater from Lake Oneida.	JUNCTION OF EMBANKMI AND ABUTMENT, SPILLI AND DAM		
	ICEABLE	epage was observed exiting from the right hillside proximately 50 ft. downstream from the embankment/ght abutment junction. The clear flow was exiting an estimated 2 g.p.m. A wet and marshy area is cated downstream from the center of the dam. This ea may be the result of tailwater from Lake Oneida.	It is recommended that the dam be examined again in the future under two differing conditions after the vegetation has been removed. 1) When the reservoir is at or above the spillway crest. 2) When Lake Oneida is low enough to observe the outlet pipe for Boydstown Dam.
	STAFF GAGE AND RECOI		

None

DRAINS

OUTLET WORKS

Name of Dam: BOYDSTOWN DAM

NDI # PA 00270

VISUAL EXAMINATION OF

CRACKING AND SPALLING OF The outlet conduit could not be observed at CONCRETE SURFACES IN the time of the inspection because it was

submerged.

OUTLET CONDUIT

OBSERVATIONS

Should be inspected when Lake Oneida is at low pool.

REMARKS OR RECOMMENDATIONS

INTAKE STRUCTURE MA

Masonry stone circular tower with 3 gated inlets.

Two of the gates to those inlets appear operational.

The third or lowest valve stem is disconnected.

The valve stem should be repaired and a preventive maintenance schedule implemented.

OUTLET STRUCTURE

The outlet structure was submerged and could not be observed at the time of inspection.

Should be inspected when Lake Oneida is at low pool.

OUTLET CHANNEL

Lake Oneida is located immediately downstream from the dam. The outlet conduit discharges directly into Lake Oneida.

EMERGENCY GATE

The gate located in the center of the intake tower which controls the outlet pipe flow appears to be operational. Additional valves located on the downstream end of the outlet pipe and the former water supply pipe are submerged and could not be observed. The 24 in. blow-off pipe is reportedly open into the reservoir.

UNGATED SPILLWAY

Name of Dam: BOYDSTOWN DAM NDI # PA 00270

Should repair the weir, possibly REMARKS OR RECOMMENDATIONS as a part of increasing the spillway capacity. The concrete weir is deteriorated and in poor condition. OBSERVATIONS Former patchwork has chipped out. VISUAL EXAMINATION OF CONCRETE WEIR

Should be protected with additional The shoreline, partially lined with deteriorated riprap, slopes toward the center of the reservoir. APPROACH CHANNEL

The upper half of the discharge channel should be replaced or riprap.

DISCHARGE CHANNEL

The upper half of the discharge channel is in a very deteriorated condition, including the right training wall which is tilted (several in.) into the spillway. The downstream half was replaced in 1954 and is in good condition.

repaired.

BRIDGE AND PIERS

Not Applicable

GATED SPILLWAY - Not Applicable

Name of Dam: BOYDSTOWN DAM NDI # PA 00270

OBSERVATIONS VISUAL EXAMINATION OF

CONCRETE SILL

APPROACH CHANNEL

DISCHARGE CHANNEL

BRIDGE AND PIERS

GATES AND OPERATION EQUIPMENT

REMARKS OR RECOMMENDATIONS						
INSTRUMENTATION - Not Applicable						
Name of Dam: BOYDSTOWN DAM NDI # PA 00270 VISIBL EXAMINATION	MONUMENTATION/SURVEYS	OBSERVATION WELLS	WEIRS	PIEZOMETERS	OTHER	

RESERVOIR

Name of Dam: BOYDSTOWN DAM NDI # PA 00270

OBSERVATIONS VISUAL EXAMINATION OF

SLOPES

The slopes adjacent to the reservoir were well vegetated and appeared stable.

The amount of sedimentation in the reservoir is unknown.

SEDIMENTATION

DOWNSTREAM CHANNEL

BOYDSTOWN DAM Name of Dam:

NDI # PA 00270

VISUAL EXAMINATION OF

OBSERVATIONS (OBSTRUCTIONS, DEBRIS, ETC.)

CONDITION

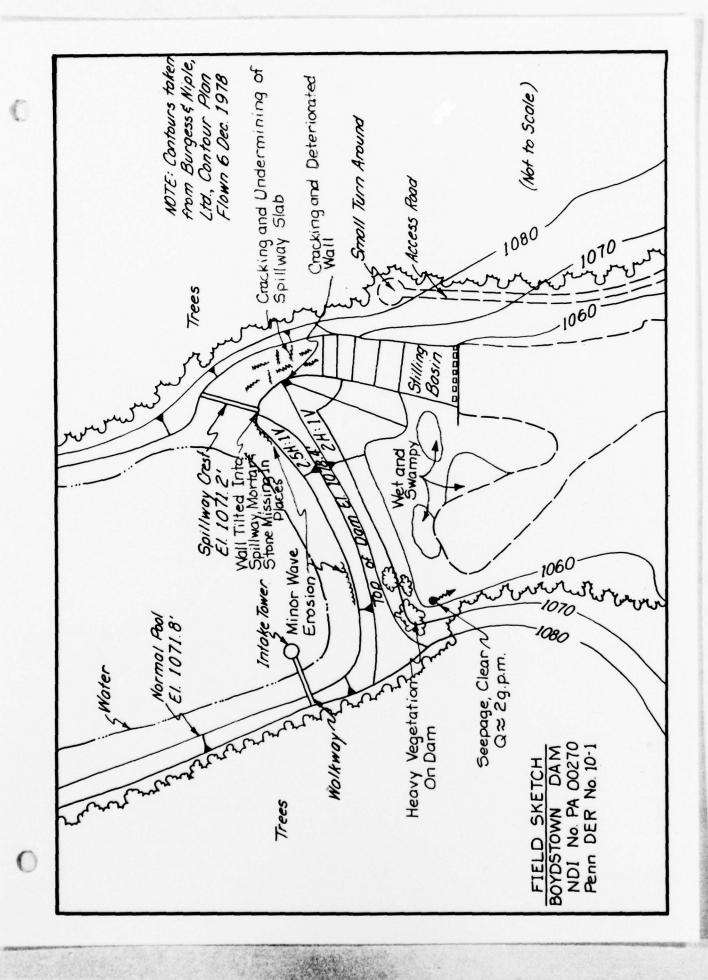
Lake Oneida is located immediately downstream from the dam. A bridge crossing over Lake Oneida is located 1300 ft. downstream from Boydstown Dam.

SLOPES

The stream channel slope downstream from Oneida Dam is mild, averaging 10-15 ft. per

APPROXIMATE NO. OF HOMES AND POPULATION

Lake Oneida Reservoir and Dam (NDI # PA 00272) Oneida Dam and therefore placed the dam in the "High" hazard category. are located downstream from Boydstown Dam. A Phase I Inspection Report for Lake Oneida Dam indicated 60-80 people downstream from Lake



APPENDIX B

CHECK LIST - ENGINEERING DATA

ENGINEERING DATA DESIGN, CONSTRUCTION, OPERATION CHECK LIST

BOYDSTOWN DAM Name of Dam: NDI # PA 00270

REMARKS

See the Field Sketch of this report. PLAN OF DAM

See Plate 1 of this report. REGIONAL VICINITY MAP

See Section 2 of this report and the 1915 Water Supply Commission Report (available in PennDER File No. 10-1). CONSTRUCTION HISTORY

None available TYPICAL SECTIONS OF DAM

No design data available HYDROLOGIC/HYDRAULIC DATA

OUTLETS - PLAN,

DETAILS.

CONSTRAINTS,

None available DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS Reservoir and rainfall data are available from 1954 to present.

Name of Dam: BOYDSTOWN DAM

NDI # PA 00270

ITEM

REMARKS

DESIGN REPORTS None available

None available. See Appendix E for the regional geology. GEOLOGY REPORTS

DESIGN COMPUTATIONS None available HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES

MATERIALS INVESTIGATIONS None available BORING RECORDS LABORATORY FIELD POST-CONSTRUCTION SURVEYS OF DAM None available

BORROW SOURCES No information available

Name of Dam: BOYDSTOWN DAM NDI # PA 00270 ITEM

REMARKS

MONITORING SYSTEMS None

See Section 2 for as Several modifications were performed in the early history of the dam. much of the detail that is available. MODIFICATIONS

Records available since 1954 indicate that in modern history of the dam, the highest pool was in 1954. HIGH POOL RECORDS

POST-CONSTRUCTION ENGINEERING 191
STUDIES AND REPORTS CU

1915 Water Supply Commission Report on the dam, available in PennDER file. Currently a detailed evaluation of the spillway capacity is being performed in connection with Lake Oneida Dam.

PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS

27 July 1897 - Overtopped - 100 foot section at right abutment washed out. 28 August 1903 - Overtopped - 130 foot section in the center of the embankment washed out. I October 1911 - Heavy spillway discharge, washed away downstream apron (information available in 1915 Water Supply Commission

MAINTENANCE None available OPERATION RECORDS

Name of Dam: BOYDSTOWN DAM NDI # PA 00270

ITEM

REMARKS

SPILLWAY PLAN,

SECTIONS,

No drawings showing the current configuration for the entire spillway is available. and DETAILS

No information available OPERATING EQUIPMENT PLANS & DETAILS

CHECK LIST HYDROLOGIC AND HYDRAULIC DATA ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 13.6 sq.mi.
1071.2 ft. ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): (236 acft.)
1078.4 ft. ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): (514 acft.)
ELEVATION MAXIMUM DESIGN POOL:Unknown
ELEVATION TOP DAM: 1078.4 ft.
CREST: Spillway
a. Elevation 1071.2 ft. b. Type Open channel c. Width 60 ft. d. Length Approximately 290 ft. e. Location Spillover Left abutment of dam f. Number and Type of Gates None
OUTLET WORKS:
a. Type Stone masonry riser tower and outlet conduits b. Location At right end of embankment c. Entrance inverts Unknown d. Exit inverts Unknown e. Emergency draindown facilities 20 in gated blow-off pipe
HYDROMETEOROLOGICAL GAGES: None
a. Type b. Location c. Records MAXIMUM NON-DAMAGING DISCHARGE Unknown
UIIKIIOWII

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

- Overall View of Dam
 - Upper Photo Overall View of Dam from Left Abutment Lower Photo - Overall View of Downstream Portion of Dam from Left Abutment
- Photo 1 View of Spillway Looking Downstream
- Photo 2 View Looking Upstream at Crest of Spillway
- Photo 3 View Looking Downstream at Spillway Discharge Channel and Stilling Basin
- Photo 4 View Looking Upstream at Reconstructed Section of Spillway Discharge Channel
- Photo 5 View Looking Upstream at Intake Tower
- Photo 6 View Looking Downstream of Intake Tower and Upstream Slope of Embankment
- Photo 7 View Looking Downstream from Crest of Embankment (Note: Tailwater level is controlled by the level of Lake Oneida.)
- Photo 8 View of the Location of the Submerged Outlet Pipe
- Photo 9 Close-up View of Cracking and Loss of Material Beneath Spillway Slab
- Photo 10 Close-up View of Right Training Wall at the Entrance to Spillway Channel
- Photo 11 View of Seepage from Right Abutment Toe Area
- Photo 12 Close-up View of Right Abutment Toe Area
 (Note: Seepage is located near fragmented sandstone.)
- Note: Photographs 1-10 were taken on 27 June 1979. Photographs 11 and 12 were taken on 19 July 1979.

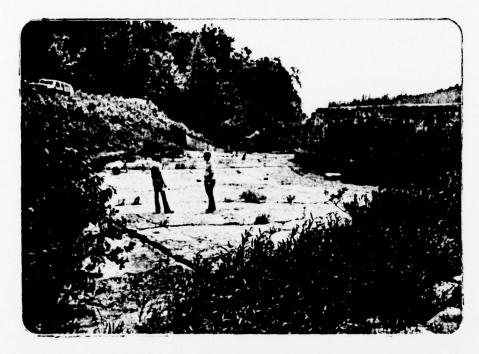


PHOTO 1. View of Spillway Looking Downstream



PHOTO 2. View Looking Upstream at Crest of Spillway

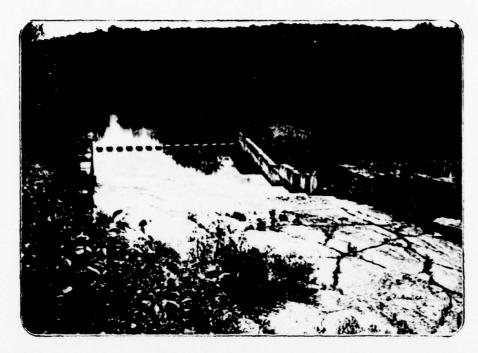


PHOTO 3. View Looking Downstream at Spillway Discharge Channel and Stilling Basin



PHOTO 4. View Looking Upstream at Reconstructed Section of Spillway Discharge Channel

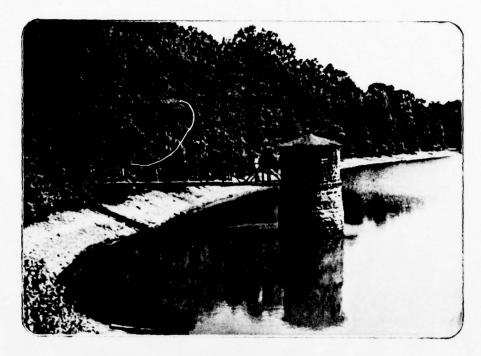


PHOTO 5. View Looking Upstream at Intake Tower

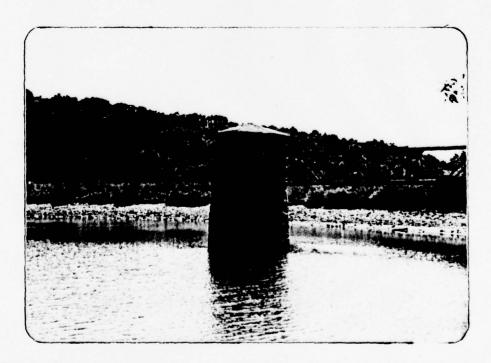


PHOTO 6. View Looking Downstream at Intake Tower and Upstream Slope of Embankment

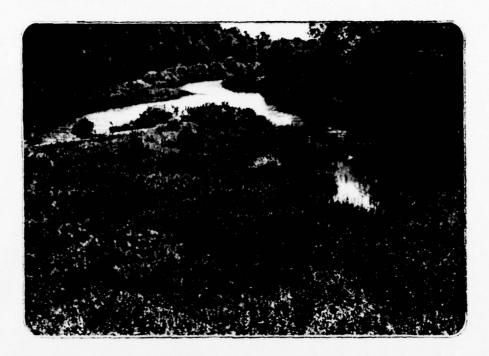


PHOTO 7. View Looking Downstream from Crest of Embankment (Note: Tailwater level is controlled by the level of Lake Onelda.)



PHOTO 8. View of the Location of the Submerged Outlet Pipe



PHOTO 9. Close-up View of Cracking and Loss of Material Beneath Spillway Slab



PHOTO 10. Close-up View of Right Training Wall at the Entrance to Spillway Channel



PHOTO 11. View of Seepage from Right Abutment Toe Area



PHOTO 12. CLose-up of Right Abutment Toe Area (Note: Seepage is located near fragmented sandstone.)

APPENDIX D

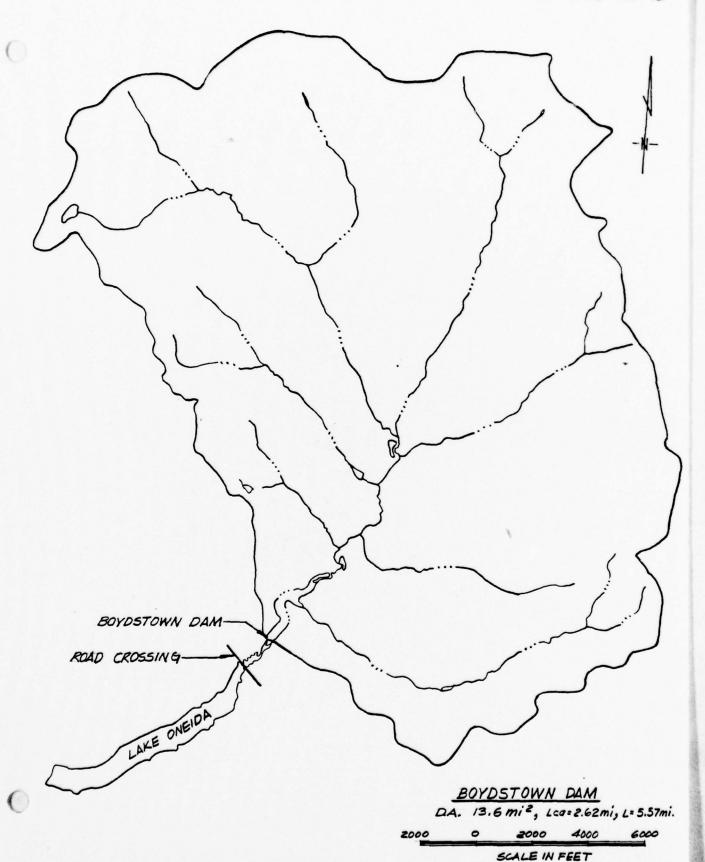
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

e en 15 mars 5 420 MICHAEL BAKER, JR., INC. THE BAKER ENGINEERS Box 280 Beaver, Pa. 15009 Computed by ___ Table of Contents Drainage Area Plan Calculations & data prepared by Burgess and Niple, Ltd.

(see index - page 2)

Overtopping potential Dom Breach Analysis

A STANDARD COM



List of Enclosures

Unit Hydrographs	2	sheets
Synopsis of FLOOD ROUTING RESULTS		
Text	4	sheets
PLAN Lake Oneida Dam	1	sheet
PLAN Boydstown Dam	1	sheet
Lake Oneida Dam Rating Curves	1	sheet
Boydstown Reservoir Rating Curves	1	sheet
Boydstown Reservoir Tailwater Rating	1	sheet
Boydstown Dam Storage & Area vs. Elevation	1	sheet
Synopsis of FLOOD ROUTING RESULTS - SUPPLEMENT		
Text	4	sheets
Regional Clark Parameters Plot	1	sheet
Inflow Outflow Hydrograph Plots	2	sheets
Boydstown Reservoir Storage Curve dated October 18, 1943	1	sheet
Selected HEC-1-DAM Computer Output	6	sheets

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Burgess & Niple, Limited February 19, 1979

LAKE ONEIDA DAM Synopsis of FLOOD ROUTING RESULTS

The total drainage area at Lake Oneida Dam is 16.41 square miles, while the drainage area at the upstream Boydstown Dam is 13.58 square miles. Probable maximum precipitation for the total drainage basin was derived from Hydrometeorological Report No. 51, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian", prepared by the National Weather Service in June, 1978. Appropriate precipitation losses for the basin were determined from charts provided by Pittsburgh District, Corps of Engineers. The resulting total rainfall and runoff for a 72 hour probable maximum storm were 29.4 and 26.2 inches, respectively. The similar values computed for a storm of one-half the probable maximum were 14.7 and 12.0 inches, respectively.

Runoff hydrographs from the watershed were computed by the unit hydrograph method. The Pittsburgh District Corps of Engineers supplied a six hour duration unit hydrograph for Connoquenessing Creek at Oneida Dam which they had developed for a previous study. This unit hydrograph was transformed to Boydstown Dam and also to the area between Boydstown and Oneida Dams. The transformation was done using a procedure developed by Gert Aron and Arthur Miller at Pennsylvania State University and presented in the American Water Resources Association Bulletin of April, 1978, under the title of "Adaptation of Flood Peaks and Design Hydrographs from Gaged to Nearby Ungaged Watersheds". In order to provide better definition to the flood hydrographs, one hour duration unit hydrographs were then derived from the six hour duration unit hydrograph by the S-curve method. Finally, the one hour duration unit hydrograph for the area between the dams was proportioned into unit hydrographs representing runoff from the following subareas:

from Boydstown Dam to the road crossing of Lake Oneida, and from the road crossing to Oneida Dam. This final step was done in order to perform flood routing computations through the total stream hydrologic system.

Elevation versus storage data were derived from the two-foot contour interval topographic maps of the reservoirs and total stream systems that were flown for this study. Elevation versus discharge data for flow over the spillways, and also over the dams, were determined by using the HEC-2, Water Surface Profiles, computer program. This method was used in order to reflect any influence of tailwater submergence on the discharge ratings. The spillway capacity at Boydstown Dam was found to be 3,100 cubic feet per second at the top of dam, Elevation 1078.4 and at Oneida Dam 3,900 cubic feet per second at the top of dam, Elevation 1063.7. The HEC-2 program was also used to determine the discharge rating data for the road crossing of Lake Oneida.

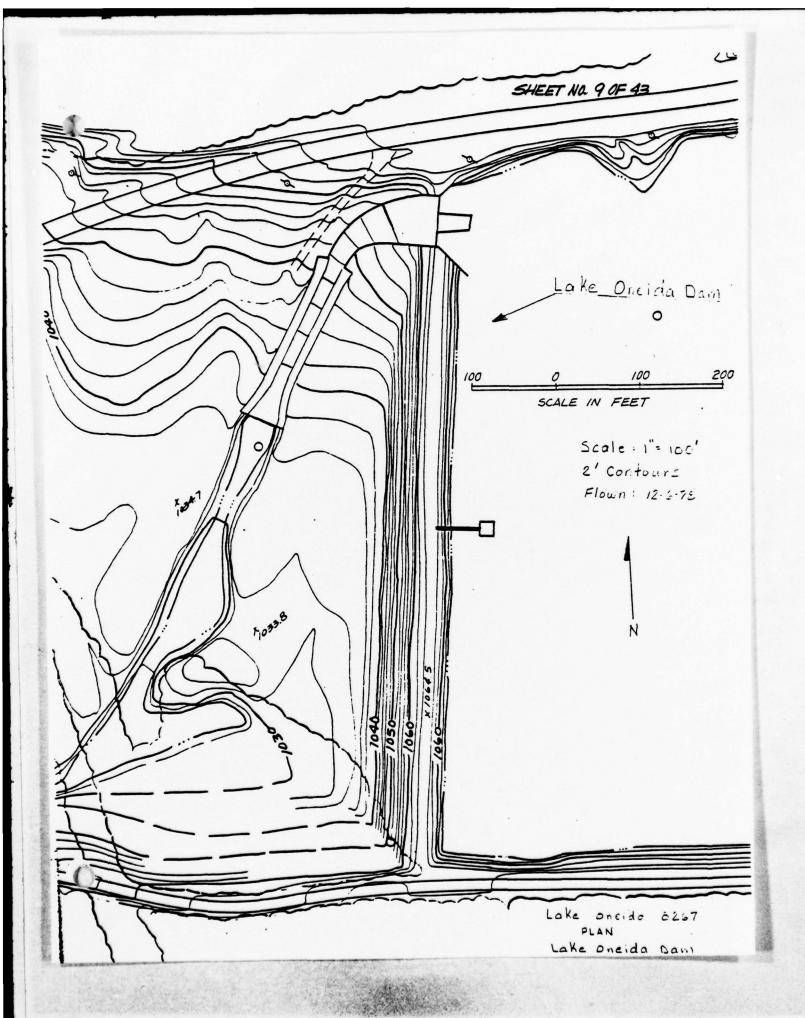
Flood runoff hydrograph routing computations were performed using the HEC-1, Flood Hydrograph Package (Dam Safety version), computer program. The peak discharge of the inflow hydrograph for the probable maximum flood (PMF) at Boydstown Dam was found to be 11,760 cubic feet per second and for the one-half PMF it was 5,670 cubic feet per second. The same peak inflow discharges at Oneida Dam were found to be 14,430 and 6,940 cubic feet per second, respectively. Assuming that flow could occur over dams without their failing, the maximum water surface elevations for the PMF and one-half PMF at Boydstown Dam were 1082.2 and 1080.2, while at Oneida Dam the similar elevations were 1066.6 and 1065.1. Therefore, both dams would be overtopped by both the PMF and the one-half PMF.

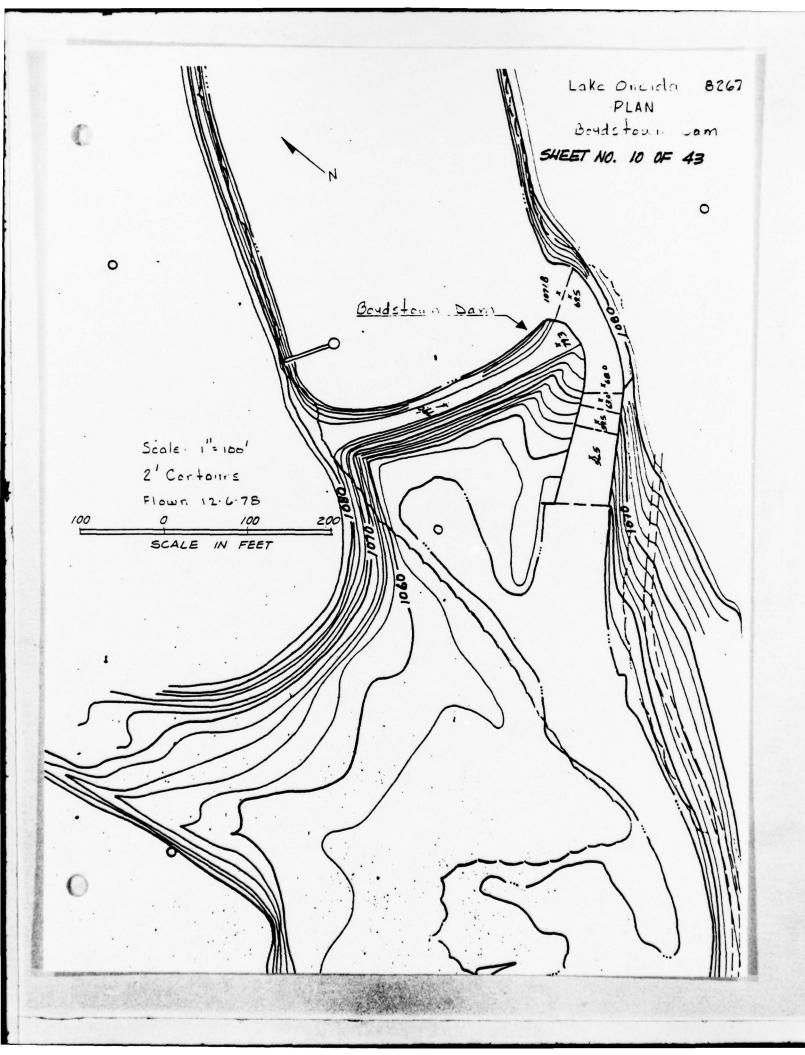
An analysis to determine the height of dams necessary to prevent overtopping while employing the existing spillways was performed by considering flow over the spillways only. The resulting PMF maximum water surface elevations at Boydstown and Oneida Dams were 1089.9 and

1074.4, respectively. Thus, Boydstown Dam would have to be raised 11.5 feet and Oneida Dam 10.7 feet to contain the PMF. The resulting one-half PMF maximum water surface elevations at Boydstown and Oneida Dams were 1082.0 and 1066.3, respectively. Thus, Boydstown Dam would have to be raised 3.6 feet and Oneida Dam 2.6 feet to contain the one-half PMF.

An alternative analysis to determine the height of Oneida Dam necessary to prevent overtopping while employing its existing spillway was performed by considering flow over its spillway only, but allowing flow at Boydstown Dam to be over the spillway and dam. The resulting PMF and one-half PMF maximum water surface elevations at Oneida Dam were 1074.6 and 1066.3, respectively. For the PMF, this is only 0.2 foot higher than if Boydstown Dam was also raised to contain the flow to its existing spillway. For the one-half PMF, the amount Oneida Dam would have to be raised remains the same whether or not Boydstown Dam is also raised. This alternative analysis does not reflect what could happen if Boydstown Dam were to fail when it is overtopped during the PMF or one-half PMF.

	Lake Oneida	eida		
	(Oneida	Dam)	Boydston	vn Dam
	PMF	IF 1/2 PMF	PMF	1/2 PMF
Peak Flow Inflow - cfs	14,430	6,940	11,760	5,670
Maximum Reservoir Stage Elevation	1,066.6	1,065.1	1,082.2	1,080.2
Peak Outflow - cfs	14,380	6,780	11,760	5,670
(1) through spillway	6,200	5,000	2,600	4,200
(2) over dam embankment	8,180	1,780	6,160	1,470
Depth of Overtopping - feet	2.9	1.4	3.8	1.8
Duration of Overtopping - hours	22	11	24	12

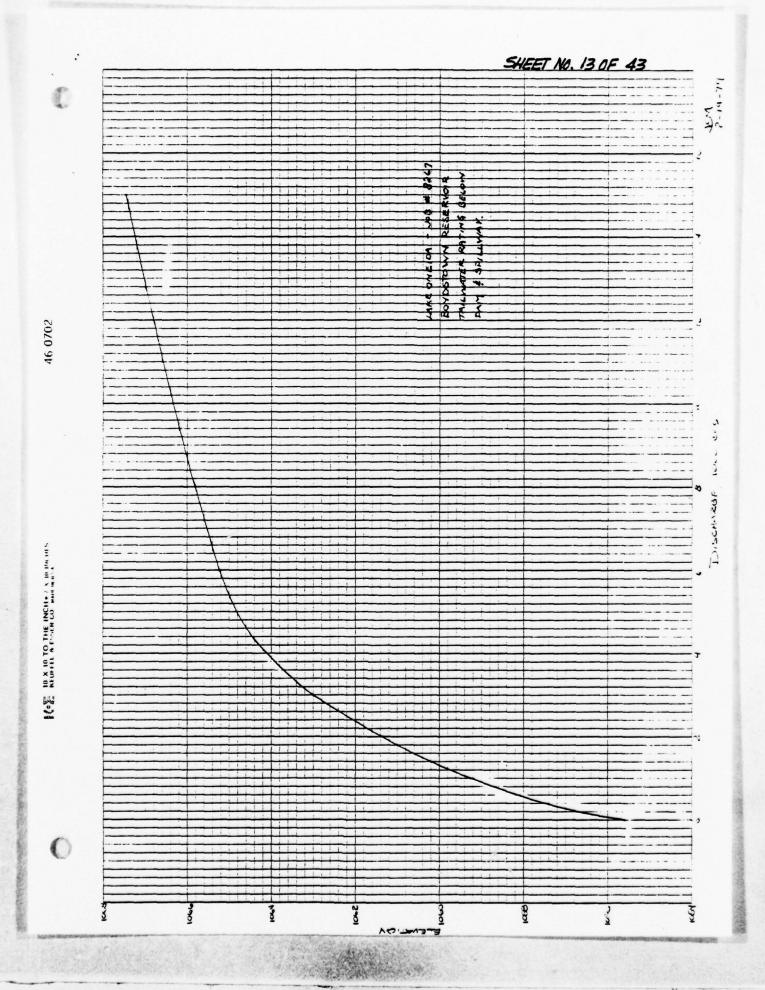


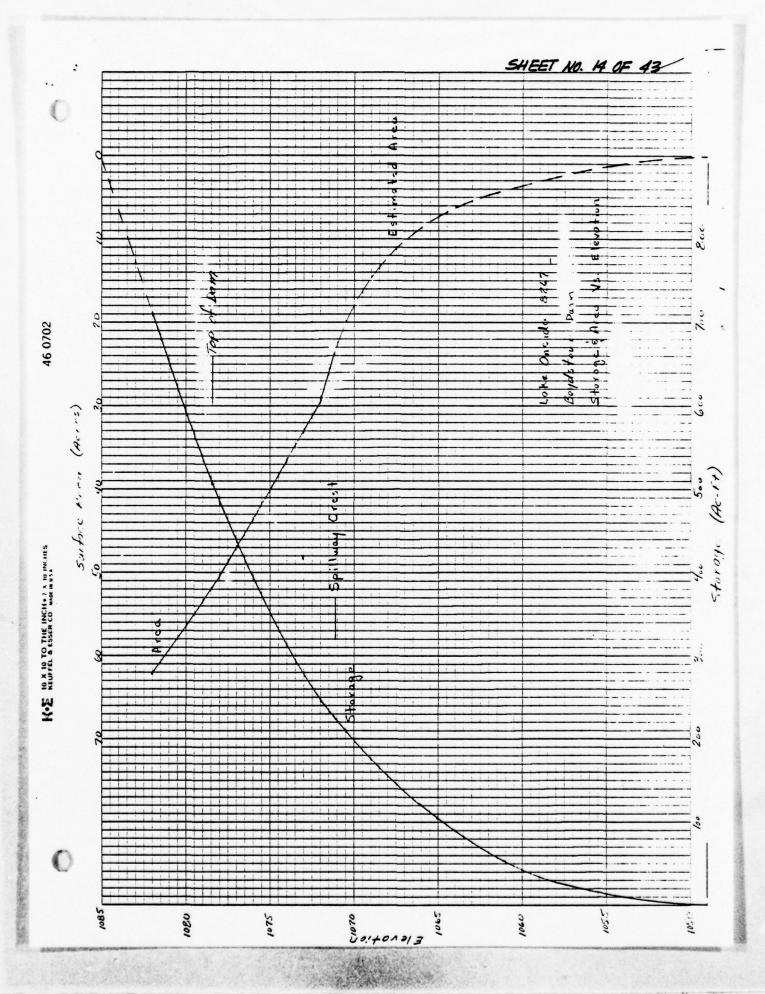


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LAKE ONEIDA DAM

Synopsis of FLOOD ROUTING RESULTS SUPPLEMENT

Adjustments to flood routing computations were made subsequent to modifications in unit hydrograph derivations for the tributary subareas. Unit hydrograph analysis was revised using optimization routines of the HEC-1, Flood Hydrograph Package, computer program, and procedures suggested in the HEC-1 User's Manual to provide regional consistency. Only changes made to the previous flood hydrograph analysis are included in the following discussion.

Four unit hydrographs (six hour durations) in the vicinity of Lake Oneida Dam were developed for a previous study by the Pittsburgh District Corps of Engineers. Locations of these unit hydrographs and their drainage areas are given in Table 1.

Table 1 LOCATIONS AND DRAINAGE AREAS OF SIX HOUR UNIT HYDROGRAPHS SUPPLIED

Location	Drainage Area (square miles)
Thorn Creek at Mouth	7.53
Connoquenessing Creek above Oneida Dam	16.41
Stony Run at Mouth	8.93
Pine Run at Mouth	3.72

One hour unit hydrographs were derived from the six hour unit hydrographs. These derivations provided best fit optimization without any predetermined restrictions and resulted in optimum Clark unit hydrograph coefficients. The computed times of concentration TC and storage coefficients R were combined into ratios, and the average

Note: This data supercedes that dated Feb. 19,1979.

regional ratio of 0.53 for R/(TC+R) was determined. One hour unit hydrographs were redetermined from the original six hour unit hydrographs to give new TC and R values for each drainage area based on the regional ratio. The sums TC+R from the second optimization were correlated to the respective drainage areas (DA) for the locations in Table 1, providing equation 1:

$$TC+R = 11.84 \text{ DA}^{0.184}$$
 (Eq. 1)

Solving the average regional ratio equation for R and substituting the result into equation 1, equation 2 results giving the time of concentration in hours:

$$TC = 5.56 \text{ DA}^{0.184}$$
 (Eq. 2)

Clark times of concentration and storage coefficients for the various subareas in the flood routing system were then computed from equations 1 and 2 and were used for flood hydrograph computation.

Revised flood hydrograph routing computations were performed using Clark subarea TC and R values for unit hydrograph definition in the HEC-1, Flood Hydrograph Package (Dam Safety Version), computer program. The peak inflow at Boydstown Dam for the probable maximum flood (PMF) would be 12,180 cubic feet per second while that for the one-half PMF would 5,880 cubic feet per second. Corresponding inflows at Lake Oneida Dam would be 15,130 cubic feet per second and 7,240 cubic feet per second. Assuming that flow could occur over both dams without their failure, the maximum water surface elevations for the PMF and one-half PMF at Boydstown Dam would be 1,082.3 and 1,080.3 while at Lake Oneida Dam the elevations would be 1,066.7 and 1,065.2. The two dams would be overtopped by both the PMF and the one-half PMF. Table 2 summarizes the existing condition flood routing results.

Table 2
EXISTING CONDITION FLOOD ROUTING RESULTS

	Lake 0 (Lake One		Boydsto	wn Dam
	PMF	1/2 PMF	PMF	1/2 PMF
Peak Inflow (cfs)	15,130	7,240	12,180	5,880
Maximum Reservoir Elevation (feet)	1,066.7	1,065.2	1,082.3	1,080.3
Peak Outflow (cfs)	14,980	7,120	12,180	5,880
Through spillway	6,280	5,080	5,700	4,260
Over Dam Embankment	8,700	2,040	6,480	1,620
Depth of Overtopping (feet)	3.0	1.5	3.9	1.9
Duration of Overtopping (hours)	22	11	23	14

An analysis to determine the height of dams necessary to prevent overtopping while employing the existing spillways was performed by considering flow over the spillways only. The resulting PMF maximum water surface elevations at Boydstown and Lake Oneida Dams were 1,090.5 and 1,075.0 respectively. Thus, Boydstown Dam would have to be raised 12.1 feet and Lake Oneida Dam 11.3 feet to contain the PMF. The resulting one-half PMF maximum water surface elevations at Boydstown and Lake Oneida Dams were 1082.3 and 1066.6, respectively. Boydstown Dam would have to be raised 3.9 feet and Lake Oneida Dam 2.9 feet to contain the one-half PMF.

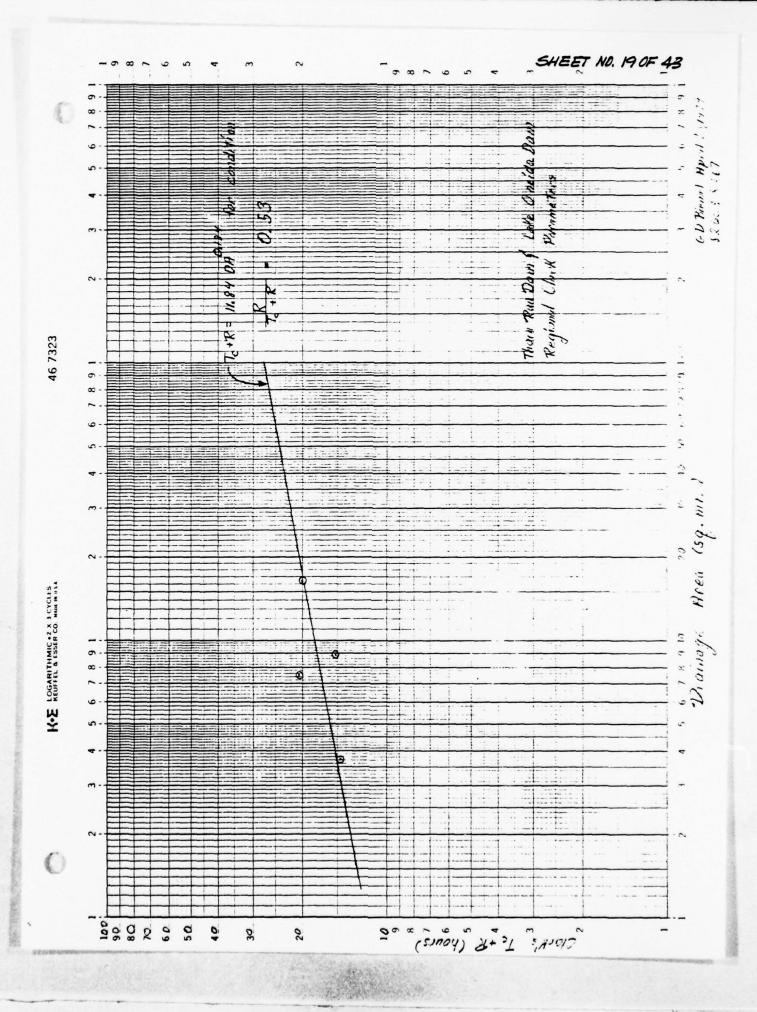
An alternative analysis to determine the height of Lake Oneida Dam necessary to prevent overtopping while employing its existing spillway was performed by considering flow over its spillway only, but allowing flow at Boydstown Dam over the spillway and dam. The resulting PMF and one-half PMF maximum water surface elevations at Lake Oneida Dam were 1,075.2 and 1,066.7, respectively. For the PMF, this is only 0.2 foot higher than if Boydstown Dam was also raised to contain the flow to its existing spillway. For the one-half PMF, the amount Lake Oneida Dam would have to be raised is 0.1 foot higher than if Boydstown Dam were also raised. This alternative analysis does not reflect what could happen if Boydstown Dam were to fail when it is overtopped during the PMF or one-half PMF.

Table 3 compares the flood routing results from this revised analysis to the results from the previous analysis.

Table 3 COMPARISON OF FLOOD ROUTING RESULTS

	Lake One PMF		Boydsto PMF	wn Dam 1/2 PMF
Existing Peak Inflow (cfs)		172 7711		1/2 1111
Revised	15,130	7,240	12,180	5,880
Previous	14,430	6,940	11,760	5,670
Change	700	300	420	210
Existing Stage (feet)				
Revised	1,066.7	1,065.2	1,082.3	1,080.3
Previous	1,066.6	1,065.1	1,082.2	1,080.2
Change	0.1	0.1	0.1	0.1
Plan A Stage (feet) ^(a)				
Revised	1,075.0	1,066.6	1,090.5	1,082.3
Previous	1,074.4	1,066.3	1,089.9	1,082.0
Change	0.6	0.3	0.6	0.3
Plan B Stage (feet) ^(b)				
Revised	1,075.2	1,066.7	1,082.3	1,080.3
Previous	1,074.6	1,066.3	1,082.2	1,080.2
Change	0.6	0.4	0.1	0.1

⁽a) Plan A assumes no flow over either dam(b) Plan B assumes flow over Boydstown Dam but not over Lake Oneida Dam



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Subject Boydstown Dam Overtopping Potential MICHAEL BAKER, JR., INC. Sheet No. 29 of 43 THE BAKER ENGINEERS Box 280 Date 7-27-79 Beaver, Pa. 15009 1085 1075 Approximately 30% PMF 1070 Percent PMF Note: This was determined from the results of the Burgess and Niple overtopping analysis.

SHEET NO. 30 OF 43 0 1081.2 1065.1 1065.5 + 1080.8 SCALCULATE INFLOW FOR AREA BETWEEN BOYDSTOWN AND ROAD CROSSING 1080.4 6070 1085 1064.5 4600 0.029 BOYDSTOWN DAM DATA TAKEN FROM BURGESS AND NIPLE STUDY DAM BREACH ANALYSIS FOR BOYDSTOWN DAM-0.5 PMF
BALTIMORE DISTRICT U.S. ARMY COE
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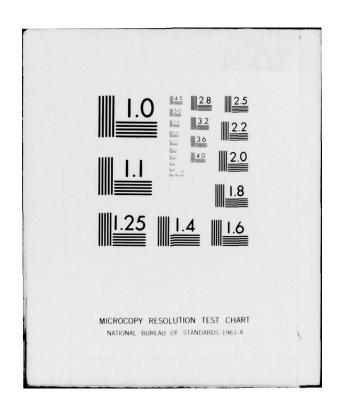
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SUMMARY OF DAM SAFETY ANALYSIS

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Station - Boydstown Dam

SUMMARY OF DAM SAFETY ANALYSIS

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SUMMARY OF DAM SAFETY ANALYSIS

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Boydstown Dam.	
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MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280 Beaver, Pa. 15009 Subject Boyds fown Dam S.O. No.

Dam Breach Analysis Sheet No. 43 of 43

Drawing No.

Computed by REH Checked by Date 8-15-79

The parameters used in the dam breach analysis were chosen based on the dam failures of 1897 and 1903. Both failures resulted in a breach approximately 100 feet wide. The breaches, which took only a short time to develop, resulted from an over topping of I ft. or less. The time to completely form the breach was determined to be 2 hours. This was based on the fact that a central core wall was constructed following the failures of 1897 \$ 1903. This wall would not fail as rapidy as the remainder of the earth embankment.

The results of the dom breach analysis indicate that the reservoir level at Oneida dam would be increased by approximately one-half fact in the event of an overtopping failure of Boydstown Dam during 1/2 PMF conditions. This corresponds to an increased discharge of 1700 c.f.s. over Oneida Dam. This increase is considered significant and could contribute to an overtopping failure of Oneida Dam.

* See discharge rating curves prepared by
Burgess and Niple (this appendix).

APPENDIX E

REGIONAL GEOLOGY

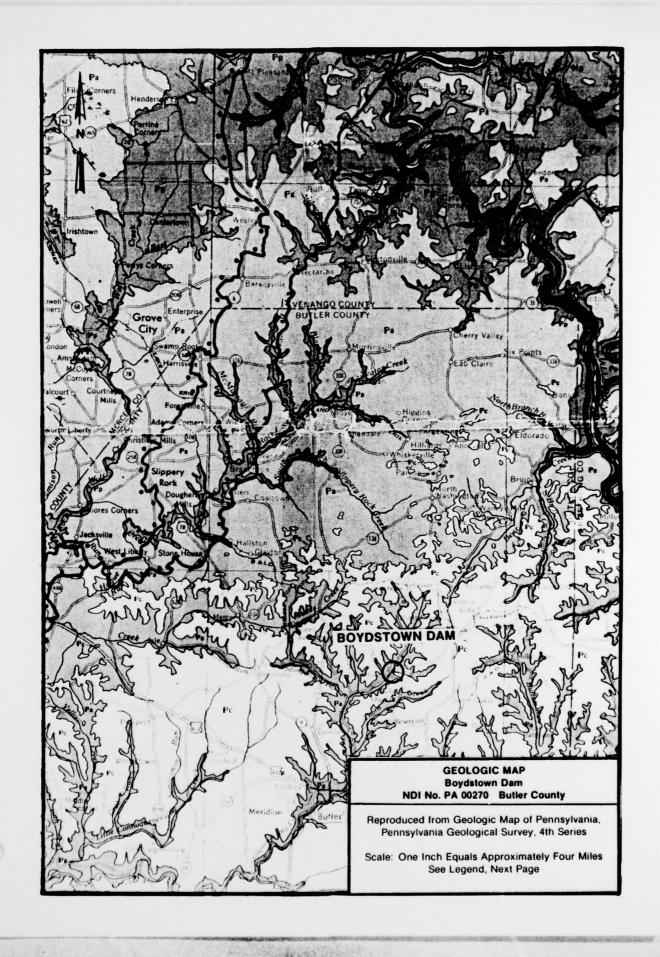
BOYDSTOWN DAM NDI No. PA 00270, PennDER No. 10-1

REGIONAL GEOLOGY

Boydstown Dam is located in the unglaciated Kanawha section of the Appalachian Plateaus Physiographic Province, a mature plateau region with moderate relief. (Because the dam is old, no specific foundation or geologic data is available from design studies.)

As shown on the following Geologic Map, the dam and reservoir are located in a portion of the Connoquenessing Creek valley which is underlain by members of the Allegheny Formation, Pennsylvanian System. Bedrock in this formation is typically cyclic sequences of sandstone, shale, limestone and coal. The dam is located near the axis of the Mount Nebo syncline; although the dip is slight, the syncline plunges gently to the southwest.

The Upper Freeport coal horizon, the uppermost unit the the Allegheny Formation, is located roughly 100 feet higher than the reservoir.



PERMIAN



Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal, base at the top of the Upper Washington Limestone.

AND PENNSYLVANIAN PERMIAN



Washington Formation

Cyclic sequences of sandstone, shale, time-stone and coal; some red shale, some mine-able coal; base at the top of the Waynes-burg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU



Monongahela Formation

Cyclic sequences of sandstone, shale, time-stone and coal; limestone provincent in northern outcrop areas, shale and sand-stone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.



Conemaugh Formation

Concensuages For status of red and gray sholes and sittstones with thin timestones and couls; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections, Brush Creek Limestone in lower part of section.



Allegheny Group

Allegieny Group Cucle sequences of sandstone, shale, lime-stone and coal, numerous commercial coals; limestones thicken westward, Van-port Limestone in lower part of section; incusives Freepart, Australia, and Clarion Formations.



Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION



Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mine-able coals.



Pottsville Group

Light gray to white, coarse grained sand-stones and conglowerates with some mine-uble coal: includes Sharp Mountain, Schuylkill, and Tumbling Run Forma-tions.

MISSISSIPPIAN



Mauch Chunk Formation

MAUCH CHURK FORTHALION
Red shales with brown to greenish gray
Jaggy sandstones, includes Greenbrier
Limestone in Fayette, Westmoreland, and
Somerset counties, Loyalhanna Limestone
at the base in southwestern Pennsylvania.



Pocono Group

Predominantly gray, hard, mossive, cross-bedded conglomerate and sandstone with some shate, includes in the Appalachian Plateau Burgoon, Shenanoo, Cunhoga, Cussewago, Corry, and Knapp Forma-tions, includes part of "Oucaya" of M. L. Fuller in Potter and Tioga counties.